The MAC Flyer

APRIL 1972

TRANSPORTS IN TURBULENCE

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The MAC Flyer

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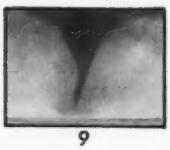
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COVER: Springtime weather — shown here along the Sierra Nevada Mountains — will soon be here.

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SQUAWK BOX

It seems crewmembers won't write much, but they will speak. So, to gather first-hand information, I spent some time with a crew on a trans-Pacific mission. Some of the things I noted: Fleet service at some stations has a reputation of leaving an aircraft dirtier than when it arrived; Even flight examiners perpetrate the old wasted words "Ah, roger, understand"; The crew bus at Hickam always pulls up with the door away from the airplane, and no one knows why; Quaint write-ups continue to bug maintenance men: "All tires due insp after this here tow"; "#3 gen is ahoggin the load"; Transient maintenance men at at least one base are not allowed to carry spare fuses; Mission messages seem to get lost and arriving crews hear "we have no knowledge of your mission"; Pax briefings are still hard to understand, especially when given during high-noise situations; High cannibalization rates lead to double work and lowered morale; Crews are still asked to carry boxes for senior personnel, then must figure out what to do with the goods when no one meets the aircraft; Unusual destinations don't get listed as addressees on mission messages. In retrospect, it seems that many little troubles persist through the years.

Throughout the mission, I was impressed with crew morale and competence — we have some outstanding people hustling aircraft around the system. To them, THE MAC FLYER says thanks — and good show. In the spirit of their good comraderie, and in the spirit of April first, we offer them a special chuckle on page 18, "It's No Longer a Man's World."

Transports in Turbulence

by Maj Ed Ross

"The aircraft departed to the northwest . . . The crew acknowledged the clearance and requested radar vectors around thunderstorm activity . . . reported departing 15,000 feet . . . reported moderate turbulence and precipitation . . . no other transmissions received . . . impacted in a near vertical attitude . . . . Investigation of the wreckage revealed . . . the horizontal trim setting was full nose down . . . ."

Not too many years ago, accident reports like this were uncomfortably common. They fit a pattern which was eventually called a "jet upset." Although we don't see very many reports like this any more, the potential for an accident of this type exists almost every day. To ensure that the potential remains unrealized, we invite you to take another look at the combination of turbulence and jet transports.

We'll begin with a review of aircraft stability and controllability factors and see how they have influenced the design of the aircraft we fly. We'll also discuss some unusual flight characteristics of these airplanes and how they can trap an unwary pilot. We'll briefly mention how turbulence is produced and then take a long look at a typical jet upset profile. We'll wind it up with some specific guidance for mixing transports and turbulence.

Stability and Controllability

Aircraft designers must consider two kinds of stability: static and dynamic. *Static stability* is an aircraft's tendency to remain in an attitude, while *dynamic stability* is its tendency to return to its original attitude if disturbed. In either type, the aircraft may exhibit positive, neutral, or negative stability. Negative stabil-

ity is usually called instability: the aircraft is considered unstable.

For example, an aircraft which has positive static stability in pitch will resist efforts to raise or lower its nose and will try to remain in level flight. With negative static stability in pitch — or static instability — the aircraft will try to change pitch attitude and will not remain in level flight by itself.

An aircraft with positive dynamic stability in pitch, if disturbed from level flight by a gust of wind or a control input, will try to return to level flight by itself. With negative dynamic stability, the disturbed aircraft will not return to its original condition and will increase its rate of change unless something is done to stop it.

Controllability is the ability of the aircraft to change attitude. It's the exact opposite of stability. For example, an aircraft parked on the ramp has a very high degree of positive static stability in pitch; it strongly resists efforts to change its pitch attitude. But it is uncontrollable. Its nose cannot be raised or lowered.

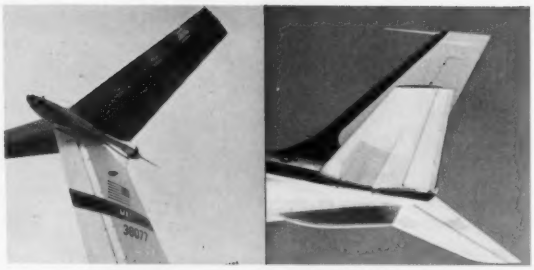
To design a useable aircraft, the engineers must provide an acceptable degree of stability and controllability throughout the aircraft's planned operating envelope. They must constantly compromise between these two conflicting characteristics, depending on the aircraft's eventual missions.

To be effective, different aircraft types require varying degrees of stability and controllability. A fighter plane designed for air-to-air combat, for example, must be very controllable but not necessarily very stable. The designers would specify large control surfaces and decrease the area of the stabilizing surfaces to trade stability for improved controllability. In a large transport or bomber, the designers would sacrifice some degree of controllability for improved stability. There would be no need for these aircraft to be able to perform aileron rolls or high-g maneuvers.

While some degree of positive stability is probably desirable in all aircraft, it is not essential. Some special purpose aircraft — like racing planes — are statically and dynamically unstable in one or more axes. Helicopters, due to their unique rotary wings, are statically and dynamically unstable in all axes.

Typical Jet Transport Design Characteristics

The horizontal tail surfaces on jet transports are designed to provide a very high degree of positive pitch stability and a reasonable amount of controllability. The horizontal stabilizers are very large — usually about three times bigger than the elevators — and the elevators have only limited movement. This combination produces a stable aircraft with adequate, but not excessive, elevator authority.



TYPICAL TRANSPORT TAILS. Large horizontal stabilizers produce positive pitch stability but can overpower the smaller elevators if mistrimmed.

The drive mechanisms, which move the horizontal stabilizer to provide pitch trim, are slow-moving and not designed to operate under heavy aerodynamic loads. A large out-of-trim condition at high speeds may stall out the drive and the stabilizer cannot be moved until the load is reduced.

On many aircraft, the engines are mounted below the aircraft's center of gravity. This means that power changes will produce changes in pitch attitude; increased power will raise the nose while decreased power will lower the nose.

The wings on most jet transports are tapered, flexible, and swept back to some degree. Tapered flexible wings are desirable for several reasons, but they are subject to a phenomenon called "aeroelastic-tip-unloading" under high-g loads. This means that when the aircraft is under high-g loads, the wing tips tend to twist leading-edge-downward, reducing the wing's angle of attack near the tips and reducing lift in this area. When this happens, the center of lift moves forward on the wing and the aircraft tends to pitch up.

Wing sweepback is used to increase the critical mach of a given airfoil and to improve the aircraft's lateral stability. However, sweptback wings tend to stall tip first, which causes the center of lift to shift forward and produces a pitch-up, aggravating the stall. To help overcome this tendency, sweptwings are usually designed with less angle of incidence at the tip than at the root (called wing wash-out) and are usually built with stall strips and vortex generators to improve their stall characteristics.

Additional Pitch-Up Problems

At high angles of attack, the horizontal tail surfaces may enter the wing wake. This wake is flowing downward and will tend to force the tail down and the nose of the aircraft up. If, at the same time, the wing is stalled and has stalled at the tips first, the wing tip vortices will move inboard toward the fuselage which

will increase the velocity of the downwash at the tail.

The fuselage can also contribute to the problem. At extremely high angles of attack, the airflow around the fuselage will produce strong cross-flow separation vortices which increase the downwash on the horizontal tail surfaces.

Because of all these factors we've mentioned — and others that are beyond the scope of this article — one fact becomes clear; a modern jet aircraft, which is normally stable in pitch, may become unstable in pitch when operated at high angles of attack.

This characteristic is not uncommon. It is the reason for the pitch-up problems experienced by Mig-15 pilots during the Korean War, for the wild gyrations performed by F-101s when they are stalled, and for the out-of-control maneuvers sometimes performed by F-4s. It is also the reason why, during its Category II flight tests, the C-141 exhibited a pitch-up tendency when stalled in all configurations.

Elaborate warning systems have been installed on many aircraft to help pilots avoid the area of pitch instability. Angle of attack indicators, stick shakers, and stick pushers are examples of the most common types.

Phugoidal Oscillation

This characteristic, which has been described as sort of a dutch roll in pitch, is common to all aircraft and is the result of the designers' compromise between stability and controllability. Basically, it's a slow, long term pitching movement during which the aircraft climbs and descends at a nearly constant angle of attack, slowly converting potential energy to kinetic energy and back again. In all aircraft which have positive dynamic stability in pitch, these oscillations will eventually dampen out and the aircraft will return to level flight.

This condition can be demonstrated in still air by trimming the aircraft for hands-off flight and bumping the control column slightly forward or aft. The aircraft will slowly hunt up and down and gradually return to level flight. A full cycle takes about 120 seconds in most jet transports.

STARLIFTER STALL STRIPS improve the aircraft's pitch stability characteristics by stalling the wing root first.

This phenomenon is not new. Actually it is the underlying reason for the two-minute sextant shot — based on the phugoidal oscillation time for a C-47.

There is now some evidence to show that phugoid oscillation — under some circumstances — could be affected by turbulence. If the wave length of the disturbance was exactly right, and it was encountered at precisely the right moment, it could reenforce the phugoid and cause temporary pitch instability. Some experts believe these conditions could suddenly produce pitch attitudes up to 40 degrees nose high. Also, under these circumstances, the aircraft would be exposed to severe short-term turbulence effects — shaking and buffeting — which would tend to hide the developing long-term problem.

Turbulence Producers

Thunderstorms are naturally at the top of the list of turbulence producers. Wind speeds of 250 to 300 knots are common inside thunderstorms, and experts say the winds may be as high as 400 knots in some storms. Thunderstorms also contain massive vertical wind components — either up- or downdrafts — which may be located right next to each other. To add to the problem, thunderstorms are often hidden in other clouds, and the strong turbulence associated with them may be found outside the storm itself.

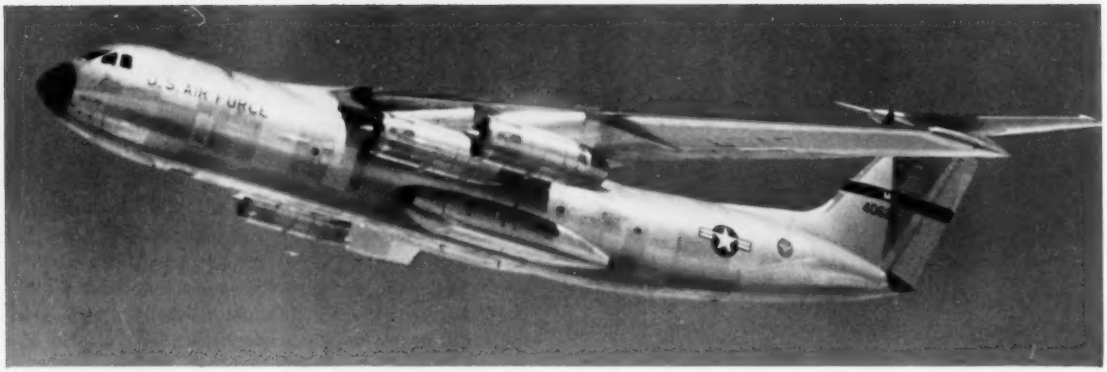
Clear air turbulence can also be rough. There are several types but we'll just consider two of the most common: jet stream and mountain wave turbulence.

Jet stream turbulence is caused by strong wind shears in the vicinity of the jet. This turbulence can be forecast with some degree of accuracy and should seldom catch a pilot by surprise.

Mountain wave turbulence, under the right conditions, can extend from the surface to an altitude about 20 times the height of the mountains and can be found as far as 150 miles downwind of the hills. It's also possible to find a jet stream in a mountain wave area, and the combination of the two can produce exceptionally severe turbulence.

The Classic Jet Upset

Jet upset accidents and incidents follow a predictable three-part pattern. In the first part the aircraft encounters turbulence and pitches up. Moments later, the aircraft is upset into a dive. The final portion of the pattern involves difficulty recovering from a nose-low, high-speed condition. The difference between a jet upset accident



PRELUDE TO AN UPSET. Heavy jets are most susceptible to turbulence-induced stability problems while climbing.

and an incident is usually measured only in pilot technique.

Pitch-Up

The first stage of a jet upset usually begins with the aircraft in a climb between 15 and 20,000 feet, in clouds, and near — but not actually in — thunderstorm activity. While climbing with less than normal cruise airspeed and a higher than normal angle of attack, the aircraft encounters strong turbulence, usually in the form of a massive updraft. The crew's first indications are heavy positive g-loads, and an extreme, almost instantaneous, increase in vertical velocity. The airspeed may surge up initially but then begins to fall rapidly.

When the gust was encountered, the aircraft's angle of attack increased drastically. It is difficult to determine the exact amount of increase, but the angle of attack may go as high as 20 degrees or more — well outside the aircraft's normal flight envelope. Because these are flight conditions for which the aircraft was not designed, the aircraft's normal pitch stability may not be present. Due to the design factors and compromises we discussed earlier, the aircraft could become statically and dynamically unstable in pitch, causing the nose of the aircraft to go up.

The pilot responds to the heavy positive g, increased rate of climb, and falling airspeed, by pushing forward on the control column. This control input is partially effective, but because of the small elevators on the aircraft and the limited amount of down elevator control available, it doesn't seem to do enough. To get more response, the pilot begins trimming nose down. He may also add power because of the rapidly falling airspeed. As we mentioned, on some aircraft, because of their low engine mounts, this increased power will add to the pitch-up.

At this point, things are becoming very confusing in the cockpit. In addition to the massive updraft which is causing the biggest trouble, the aircraft is probably in severe gusty turbulence and precipitation. There is a great deal of noise, and the whole aircraft is shaking and buffeting. The instruments are hard to read because both the panel and the pilots are bouncing around. Additionally, the pilot knows he's got an aircraft that isn't responding to the controls the way he feels it should, and he realizes that if he doesn't get the nose down soon, he's going to run completely out of airspeed and ideas. He continues to apply down elevator and keeps trimming until the stabilizer is trimmed full nose down.

Then, suddenly, everything reverses.

Upset

As abruptly as it entered the updraft, the aircraft suddenly leaves it and may just as quickly encounter a strong downdraft. With the control column still forward, and full nose down trim applied, the angle of attack drops rapidly and the g forces reverse, going from heavy positive g to zero or negative g.

This period of zero or negative-g flight has been reported in virtually all jet upsets and may be the pilot's best indication of the beginning of the upset portion of the maneuver.

While the aircraft is transitioning from nose up to nose down, the wing has gone from a positive to a negative angle of attack and is actually trying to develop negative lift, or lift on the bottom of the airfoil. With this negative angle of attack, all the designers' tricks, like wing wash out, operate in reverse. If the wing approaches a negative angle of attack stall — which it may do very quickly — the formerly stabilizing refinements will act as destabilizing devices and the aircraft will pitch down. Because of the size of the aircraft and the great amount of inertia involved, the nose won't fall through viciously, but it will go down in a hurry.

As the upset continues, electrical power problems may develop. On many aircraft, the electrical generators are connected to the engines by a fluid drive which is not designed to operate under negative g. If the negative g portion of the upset is long enough — and long enough may be only a few seconds — generators may begin to trip off the line, adding loss of electrical equipment to the pilot's problems.

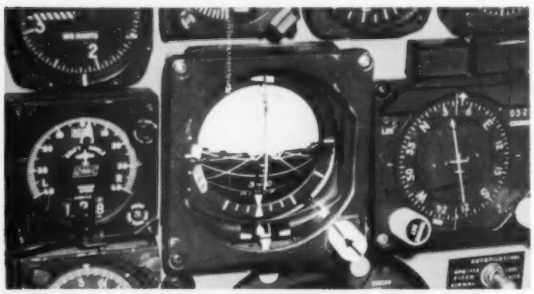
Dive

At the conclusion of the upset, the aircraft is in a nose-low attitude, with power on, full nose-down trim, and down elevator being applied. Because the airframe, which was built for high cruising speed, is highly streamlined and develops little drag, the aircraft begins to accelerate very rapidly.

As the airspeed builds up, the altimeter unwinds, and the vertical velocity indicator pegs out at the maximum rate of descent, the pilot responds with up-elevator control. Now, the aircraft is badly out of trim with the elevator calling for nose up and the horizontal stabilizer trying to force the nose down. Since the horizontal stabilizer is about three times bigger than the elevator, it is the more powerful pitch control and the nose goes down further. The pilot tries to retrim the horizontal stabilizer, but since he is understandably reluctant to release back pressure on the control column, the aerodynamic loads on the horizontal tail surfaces stall out the stabilizer trim drive and the mistrim condition continues.

Within seconds, portions of the airflow over the airframe become supersonic and shock waves develop, usually on the wings and horizontal tail surfaces. The shock waves on the horizontal stabilizer disrupt the air flow over the elevator surfaces, reducing the already limited amount of elevator authority available. The aircraft begins to buffet.

Now the pilot begins trying everything he can think of to slow the aircraft and stop the descent. He pulls the throttles to idle — which might lower the nose even more if the engines are mounted below the aircraft's center of gravity. He deploys the spoilers — which may not extend because of the high speed — and he may try lowering the landing gear.



YOUR BEST FRIEND in turbulence may mislead you. Cross-check other gages; go easy on power and trim.

Recovery

From this point, after the dive is established, the upset follows one of two patterns. In the first, there is no recovery and the aircraft goes in almost vertically, with very high airspeed and the horizontal trim still set full nose down.

In the second, with good pilot techniques and enough altitude available, the aircraft is recovered. The pilots release some (or all) of the back pressure on the control column and retrim the horizontal stabilizer. Then, by using up-elevator and nose-up trim, they are able to stop the descent and get things under control again. As a point of interest, the positive g forces imposed during recovery from some of these dives have been high enough to tear engines completely off the wings.

What Can We Do About It?

In a word, plenty. Since we've uncovered the patterns of jet upset accidents, we have learned not only how they're caused but how they can be prevented. The procedures which we'll next discuss represent the latest thinking on the subject.

Avoid turbulence. This is the first line of defense and should be your planned course of action on all flights. If you can't avoid it, prepare for it. Your flight manual will give you specific procedures for your aircraft and you should follow them, but we would like to offer these additional points for your consideration.

- If possible, penetrate turbulent air at an altitude 4- to 8,000 feet below your normal cruising altitude. This will allow you a greater airspeed margin between low speed stall and high speed buffet and will provide better control response.
- Try to enter turbulence with a near normal angle of attack, or less. Level cruise or a descent is fine, but try to avoid turbulence while you're climbing. If you are climbing and things start getting rough, level off.
- Trim the horizontal stabilizer for your penetration airspeed and *leave the trim alone.* Make it a habit to note your horizontal trim setting in normal cruise and remember it. If you don't have time to establish penetration speed and trim for it, use your normal cruise trim setting. It won't be exactly right, but it will be within

one unit of being right and will be close enough to prevent massive mistrim conditions that are so common in jet upsets.

- Set the power for penetration speed and don't be quick to change it. Change power settings only for large and persistent airspeed changes, and then only if you're sure you really have to. Remember the pitch changes — if any — you'll get when you change power.
- Tighten your seat belt and shoulder harness as tight as you can, and have the rest of your crew do the same. There will be plenty of things flying around the cockpit without adding your bodies to the congestion. Being strapped in tightly will also make it easier for you to read the instruments and to hang onto the controls when things really get tough.
- Plan to use the pitch hold mode of your autopilot *with the altitude hold off*, but monitor it closely. Watch the pitch trim and be ready to punch off the autopilot if it starts to mistrim the aircraft. Don't try to "help" the autopilot with control inputs and don't try to use the pitch control knob. Either of these things could increase the chances of the autopilot mistrimming the aircraft. Be alert for an autopilot disconnect and be ready to fly manually if you have to.
- If you can't use the autopilot, at least try to use the yaw damper and any other stabilizing devices your aircraft may have.
- Turn on the continuous ignition and leave it on.
- *Fly attitude.* The attitude indicator will be your best friend in turbulence, but don't trust it blindly. In several turbulence encounters one of the attitude indicators tumbled, so cross-check with the standby or with the copilot's instrument.
- Try to maintain a reasonable pitch attitude, but don't try to hold it rigidly. Plus or minus 10 to 20 degrees may be as close to level flight as you can hold, although some experts feel you may be able to hold attitude within 5 to 7 degrees of level.
- Watch for a pitch-up, with heavy positive g, decreasing airspeed, and rapidly increasing altitude. Be as gentle as you can with the aircraft, but be firm. Realize that you may not be able to get the nose back down as quickly as you'd like but try to arrest the pitch-up, hold that attitude, and wait for things to reverse. They will, very quickly.
- Your best indication of the reversal from nose up to nose down will probably be a change in g loading from heavy positive to zero or negative g. Be ready to release the down elevator pressure pretty quickly when this happens. If you let the nose get too low you're going to be in real trouble.
- Expect difficulty reading your instruments throughout the maneuver. The whole airplane and everything in it will be bouncing around and shaking violently. You probably also will be in heavy precipitation which will affect your pitot static instruments. And, because of the turbulence, pitot static instruments will be confusing even when they're reading correctly. For example, you might see airspeed and altitude increasing with the nose down and power off.
- And finally — Hang in there! Remember, severe turbulence encounters never last very long. It just seems like it at the time.

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SPRING WEATHER

A glimpse of...

what it can look like...

and what it can do.

A discussion relative to the complex meteorological phenomena which occur during rapid electron surges in the ionosphere, or . . .

LIGHTNING IS PROBABLY one of the least understood phenomena encountered by flight crews. Even the most experienced pilot finds his hands tightening on the controls when an unexpected flash illuminates his nighttime cockpit with daylight brilliance.

To help lessen this understandable fear, let's take a look at the nature, cause, and varieties of lightning. We'll discuss why lightning strikes your aircraft, where and when you may get struck, how lightning can affect your operations, and what you can do about it. So . . . let's strike out in search of some enlightening answers to these shocking problems.

The Nature and Cause of Lightning

The invention of high-speed cameras was one of the greatest breakthroughs in understanding the nature of lightning. Using these cameras, scientists found that a lightning stroke from a cloud to the ground is not simply a great spark of electricity suddenly leaping across the gap between two electrical charge centers. Instead, the sudden flash is a complex sequence of events.

Photographs show the first visible evidence of a lightning flash in the form of a "stepped leader," a faintly luminous trail of ionized gas which reaches downward from the cloud in distinct spurts or "steps" about 150 feet long. This leader twists, turns, and divides as it encounters vague "walls" of higher resistance in the atmosphere. As the leader carries the cloud's charge center nearer and nearer to the ground (or to another electrical charge center), it violently speeds up ionization in the surrounding air. This causes luminous ribbons, similar to the stepped leader, to grow from the ground toward the cloud. These are called positive streamers. These streamers eventually contact each other and a conductive path is established between the two charge centers. This entire process usually takes only a few thousandths of a second.

When this path is completed there is a tremendous surge of electrons down the path, creating the brilliant flash and explosive sound we associate with the lightning bolt. The rushing electrons quickly drain the charge from one portion of the cloud. Now a new stepped leader may form from a nearby charge area to the depleted area and, if the original ionized path is still intact, another surge of electrons (lightning bolt) will occur.

Three strokes per lightning bolt is average, but as many as 14 have occurred along the path established by the stepped leader. This multiple flash process creates the impression of flickering in large electrical storms.

Lightning

Lightning Varieties

This short discussion on the nature and cause of lightning wasn't intended to make you an expert on the subject. Hopefully though, you now have a basic understanding of the mechanics of lightning. We used the cloud to ground example for illustration, but there are several other variations of lightning.

Cloud to Cloud: negative and positive charge centers that flash from cloud to cloud, from cloud to upper air, or within the cloud. These make up the majority of all lightning strikes and are the most troublesome to aircraft. In arid regions, where the bases of the underclouds are much higher than they are in moist or cold areas, lightning flashes which do not touch the earth are very common. Lightning would rather flash from one cloud to another than travel the greater distance to the ground.

Bolts from the Blue: a rare phenomenon also found in arid regions where cloud bases are high. The name comes from an observer seeing a lightning bolt in locally clear skies, while the cloud that spawned the bolt is out of view many miles from the observer. These rarely hit the ground, but rather dissipate in the air, many miles from their source.

Sheet Lightning: in-cloud flashes that are generally hidden from view. All you see is a diffuse general illumination which lights up portions of the cloud. Often sheet lightning will light up the whole cloud as two oppositely charged regions at the top and the base of the cloud come together and neutralize one another.

Ribbon Lightning: a flash which appears to be several strokes closely paralleling each other. Actually this is the result of the ionized path of a multiple stroke flash being blown sideways by the wind. An example would be a 6-stroke lightning flash of a half-second total duration. Each of the strokes would be displaced about four feet in a 30-mile wind.

Ball Lightning: a very unusual phenomenon which leaves startled observers in its wake. The lightning ball varies in size and color. It may float for several minutes across the floor, glide down a tree or a ship's mast, negotiate its way around obstacles and disappear quietly or with a loud bang. There is an authenticated report of a lightning ball originating on the flight deck of a C-121 after a lightning strike. It proceeded down the aisle between the seats, and then disappeared in the rear of the cabin.

All these lightning varieties have one thing in common. They all involve at least one cloud charge center, pin-

pointing the cloud as the prime instigator of all lightning flashes.

Associated with lightning are thunder and ozone.

Thunder: an explosion that occurs along the length of a lightning channel. The flood of electrons instantaneously heats the air in its path to about 15,000° C,expanding it in all directions faster than the speed of sound. The rumble you hear is due to the distance between the listener and the various parts of the lightning channel.

Ozone: a faintly bluish gas with a pungent odor, often smelled in the vicinity of a lightning strike. It is caused by the ionization of oxygen molecules. Ozone is unstable and readily reverts to normal oxygen.

Why Does Lightning Strike Aircraft?

The best answer is that the aircraft is struck only when it happens to be in, or very near (within one wing span of), the natural path of a lightning bolt. But there are other theories.

The most prevalent is that an airplane is a better conductor than the surrounding air, thus shortening the distance between cloud charge centers and triggering the discharge stroke. Newman and Robb of The Lightning and Transients Research Institute say, "Little can be done in the immediate vicinity of an aircraft to control whether or not it is struck by lightning, as the aircraft, which is relatively small, can have little effect in determining the overall stroke path, which may extend several miles."

Still another theory is that the airplane becomes charged by friction or passage through a charged portion of the atmosphere. Then as it approaches another charge center, it attracts a stroke to itself, or discharges itself to the cloud center. However, the charge the aircraft is capable of carrying is so small compared to the cloud that it isn't considered an important factor. The airplane's charge might conceivably be useful to an existing stepped leader which is exploring the vicinity for avenues of low resistance.

So, if you fly near a thunderstorm you can expect lightning strikes. Period.

Will Lightning Injure Aircraft Occupants?

Injury to occupants is quite rare, and in some cases crews do not even realize that their aircraft have been struck until someone finds evidence of a strike during post flight inspection.

How Badly Will Lightning Damage My Aircraft?

When lightning does strike an aircraft, damage is usually slight. One factor which determines the extent of lightning damage — the conducting quality of the aircraft — is controllable, but only so far as design and function will allow. The usual approach to the problem is to determine the points which are most likely to be struck by lightning. Generally, these points are the nose, tail section, and wing tips.

Aircraft manufacturers subject solid metal scale models of new designs to artificial lightning from several points. Once the probable points of lightning strikes are known, detailed studies are made to determine the best protection.

Non-conductive shells such as radomes get particular attention during design since they receive many lightning strikes. Their susceptibility stems principally from their non-conductivity and their location.

If it seems odd that a non-conductive radome should be struck, remember that the radar dish and other components under the radome can send out electrical streamers, which might attract an approaching stepped leader. When lightning strikes, the radome is heated intensely and, though damage can be limited to pitting or small punctures, heat expansion of the material can cause large holes or even destruction of the radome. If a radome is damaged, debris carried aft by the slipstream can enter an intake or damage flight controls, messing up your whole day.

Since relocating the radome is usually impractical, the only alternative is to divert any lightning strokes to the skin via a conductor built into the radome.

Can Radar Attract Strikes?

There has been much speculation on this question. Scientists tell us that we would have to increase the power of today's radar by a factor of 10 for the possibility to exist. Ionization which attracts lightning discharges could be significant with very high power radars or high HF antenna voltages.

Radio Antennas: Antennas can be instrumental in leading lightning into the cabin where it can expose equipment and personnel to hazardous voltage. To combat this problem, lightning arrestors have been developed. These usually include a spark gap between antenna and aircraft structure, a blocking condenser, and a static leak resistor, all encased in a metal or glass enclosure located in the antenna lead-in. These are not intended to protect the external antenna, but simply to provide a weak spot in the antenna system which will break down and carry off the destructive peak voltage.

Control Surfaces: Because of their location, rudders and elevators are prime lightning targets and are easily damaged. Bonding jumpers are provided between the main structure and the moveable portions to provide paths of low resistance so that a large portion of the

current will be bridged to a more durable surface.

Static Dischargers: These are commonly fixed to the trailing edge of a control surface and aid in dispersing friction charges which build up on the skin of the aircraft. After a lightning strike, dischargers should be inspected and replaced if necessary. (Note: Aircraft skin friction can generate moderately high charges of about 100,000 volts and 0.0005 amperes. However, these values hardly compare with a "natural" lightning discharge of 10 to 100 million volts and 200,000 amperes.)

Small high speed aircraft frequently do not require static dischargers. The jet engine exhausts are usually sufficiently ionized to carry off most of the charges of static. Dischargers do become necessary, however, as the size of high performance aircraft increases.

Effects of Lightning on Air Operations

Lightning strikes and associated electrical phenomena are generally considered more of a nuisance than a hazard to air operations, especially when compared to turbulence, hail, and icing, the primary dangers from thunderstorms. Lightning damage is rarely serious. However, a C-124 suffered severe damage from an apparent lightning strike near Araxos, Greece, in 1963. The lightning burned a large hole in the aircraft's skin, broke cockpit windows, and turned off the ignition to three engines!

There has been considerable discussion that a lightning strike could cause an explosion in aircraft fuel tanks. Lightning could strike the fuel tank vents, ignite the vapors, and then flame back to the tank. However, this is considered possible only under very extreme circumstances.

What Can Flight Crews Do?

Lightning strikes can be quite troublesome to flight and maintenance crews alike. Ferrous metals may become magnetized, and compass readings can be rendered unreliable.

If you know you're going into an area where lightning is possible, make sure your gyro-compass is accurate. Gyros are not as prone to malfunction as a magnetic compass if a strike occurs, and should provide you with an accurate heading.

Close proximity to lightning often induces secondary currents which can inadvertently actuate electrical circuits. Cases have been reported in which passenger emergency oxygen masks have dropped from their containers, fighter-bomber tip tanks have been jettisoned, and armament pylons have been dropped. Another item to check after a lightning strike is each electrically discharged fire extinguisher. You ex-C-124 jocks will remember that one of the first things you checked after being hit by lightning was the ignition pins.

Secondary currents sometimes work through audio circuits to produce deafening crash static in the headset. It may be smart to unseat your headset a little for self-protection.

There have been many instances of crews being temporarily blinded by lightning strikes while flying at night, and the blindness can persist for several minutes. Turning up the cockpit lights to full bright, or turning on the white thunderstorm lights and then keeping your eyes on the instruments, will help prevent blindness. In severe cases you can also wear your sunglasses.

Of course the whole crew shouldn't restrict their vision this way, but if one pilot does, the loss in outside observation will be well repaid by the protection from temporary blindness. Remember too, that a lightning strike can disengage your autopilot, and if that happens unnoticed, you may find yourself in other than straight and level flight.

Helpful Hints

The golden rule of avoiding lightning is not to fly in or near thunderstorms. Avoiding lightning then, goes hand in hand with avoiding turbulence, icing, and hail. However, if you do find yourself in the middle of a thunderstorm, it may help to know these facts:

★ You are more likely to be struck below 20,000 feet.

★ Most strikes occur in the 5,000 to 10,000 foot level. However, strike probability coincides with the altitude range of cumulo-nimbus clouds, commonly found between 3,000 and 30,000 feet, occasionally higher.

★ Another method of avoiding strikes near thunderstorms is to keep a watchful eye on the ambient temperature. About 80 percent of the strikes occur in the —10°C to +10°C temperature range. A good precaution is to avoid flight at or near the freezing level. Also, remember temperatures inside and outside clouds can vary a great deal.

We can sum up by noting that since the day Benjamin Franklin flew a kite in a thunderstorm and got his first feel for electricity, we have learned a great deal about lightning and associated phenomena. Though we have learned how to take some precautions against the hazard, we are a long way from controlling it. These facts dictate that, as in all our air operations, we must use our training, good judgment, and common sense to fly safely.

(Adapted from the Lockheed Field Service Digest.)

Ten Comma
for
Helicopter

Thou shalt inspect thy aircraft lest thou giveth thy angels cause for concern.

Thou shalt not actuate thy starter unless thou verifieth the position of thy throttle, lest thou condemn thy engine and melteth thy turbine wheel.

Thou shalt not make trial of thy center of gravity, lest thou dasheth thy foot against a stone.

Thou shalt let infinite discretion govern thy movement near the earth, for there thou surely walketh in the Valley of the Shadow.

Thou shalt honor thy temperature and torque limits lest, when thou needest it most, thy engine shall faileth thee.

ommandments for pter Flying

Thou shalt maintain thy rotor rpm, for it is thy staff of life and without it thou shalt surely perish.

Thou shalt not allow thy tail rotor to catch in the thorns, for then thou shalt curse thy children's children.

Thou shalt heed the caution of the Dead Man's Curve; verily, its name containeth great truth.

Thou shalt take care when thou maketh thy approach, lest the wind turneth behind thee causing the earth to rise up and smite thee down.

Thou shalt not let thy confidence exceed thy ability, lest on the morrow thy friends have cause to mourn thee.

Recently we painfully discovered that truly . . .

It's No Longer a Man's World

IT ALL STARTED innocently enough in our August issue when we ran a small illustration of a young lady, in modified WAF garb, showing great concern over a hot cup which had overheated. Many of you probably saw the drawing, although it would not have fixed itself in your memory. Well, it hit one of our readers and produced one of our rare letters to the editor. A young lady, Capt Ayeframe, took strong exception to our "cartoon caricature" because of the girl's "questionable military dress and appearance," and she castigated our "traditional dumb blonde" approach.

No problem really — we took her complaint as valid and promptly replied with a letter expressing our regrets at wounding her sensibilities. And the matter was laid to rest, or so we thought.

Then, in our March "Squawk Box" we mentioned the dearth of letters and identified briefly the few we had received, including the hot cup flap. Unfortunately, our staff WAF read the editorial before it was printed, remembered the captain's gripe from a discussion in the WAF Lib Council, and leaked the story (with some unfortunate embellishments) to the author. Consequently, in the middle of February we were treated to the spectacle of six young ladies, led by a Susan-Anthony-type with silver leaves, who descended on the editorial officers of THE MAC FLYER and produced what could charitably be described as a scene.

With the assistance of the Chief of Safety plus some badge guys from our neighbor staff agency, the Security Police, the stormy waters were calmed and we offered to print a public retraction. Again we thought the matter was laid to rest — and again we were wrong.

It seems the activity, in its women's lib contemporary setting, threw the gals in high gear, and they decided to try official channels. So we attended a "negotiation" session, hosted by the Equal Opportunity Office. For two days we endured the slings and arrows of outraged womanhood, trying to remain chivalrous while defending our male chauvinist viewpoints. We didn't succeed; the confrontation grew to the point where one very important staff person entered the fray and the air suddenly grew clear — and very chilly.

Here are the outcomes of that session, many of which you will be seeing in our future issues. Effective April First:

★ A study group will examine the possibilities of using ten of the Air Force's first class of women pilots in MAC line assignments. (It is interesting to note that there was no effort to request or train female navigators.)

★ The deputy in each directorate and staff agency in the headquarters will be a WAF officer. We've been informed that Lt Col Cleostra Pseudo will be the deputy safety chief.

★ Capt Long Suffering Sam, dependable copilot extraordinaire, will be retired and his replacement will be Major Samantha Strongwill, sporting the same date of rank as C. R. Terror but unlike him, not "a bumbling buffoon."

★ Sgt Max Torque will have an engineer-type companion named Sgt Flo Gage, equally skilled at the panel.

★ Sgt Ty Downs, our dependable loadmaster, will be paired with Sgt Ima Beanburner, flight traffic specialist.

★ C. R. Terror, scourge of the airlanes and past master in the art of appreciating feminine pulchritude, will be toned down, and Mrs. C. R. Terror, who vanished early in C. R.'s airlift days, will be found and reinstalled in a commanding domestic position.

★ And one of our editorial positions will be re-manned (pardon the expression) by Major Hedda Cotton, a veteran writer and highly experienced commercial pilot.

I suppose we knew it had to happen sooner or later. And like all men, we had hoped it would be later. But times change, and it looks from here like you'll be seeing some *drastic* changes in your friendly flying safety rag. Don't leave us, readers — we need you now more than ever before. In fact, the first thing we'd like you to do is *have a happy April Fool's Day!*

A look at the lessons we've learned from the accidents we didn't have last year.

1971 Aircraft Incident Review

by Lt Col Benn H. Witterman
MAC/IGI

IT'S THAT TIME OF YEAR again when we look through last year's assortment of aircraft incidents and present them to you in the form of our annual incident review.

By broad definition, an incident is really an accident — it's just a matter of degree. An incident is of special value because we can learn a lesson from it without paying the inherently high price of an accident. Besides, any safety officer worthy of the name would rather prevent the first accident than the second one.

Before we look into last year's incident crop, let's go over some of the ground rules that govern the classification of aircraft mishaps.

For openers, let's glance at chart 1 for a better idea of what constitutes an incident as opposed to an accident.

AFR 127-4 categorizes aircraft types and models into various classes. Most of the MAC force, the "heavies," fall into Class E. This includes the C-5, C-141, C-135, and C-130. The main determining factor in the classification of an aircraft mishap is the number of manhours expended to repair the damage. If the manhours exceed the established limits, the mishap may be classified as a minor or major accident. An aircraft incident is a mishap that falls short of the accident category. In fact, there might not be any damage at all, except for soiled laundry and some emotional wear and tear on the crew — and other interested parties.

Incidents can involve systems malfunctions, bird strikes, dropped objects, decompression, hypoxia, and a number of other situations described in AFR 127-4 and our MAC supplement.

Type of Aircraft	Direct Manhours To Repair		
	Incdt	Minor	Major
HH-43, UH-1	0-99	100	500
RB-57F, C-140, T-29, T-39, HH-53, C-9	0-124	125	800
C-5, C-141, C-130, C-135	0-149	150	900

Chart 1

Now let's delve into last year's incident crop and sift out those items of value. Chart 2 is a quick summary, in tabular form. Bear in mind that the figures in this chart are unweighted. That is, there is no proportionate adjustment to compensate for differences such as the quantity of each type aircraft, flying hours amassed, criticality of hazard, mission hazards, and other factors. Another shortcoming of the chart is that it does not tell us if a problem has improved or worsened during the year.

A glance at the chart will show that we had 1,346

	C-5	C-141	C-130	C-135	RB-57	C-9	T-39	Misc Fixed Wing	H-1	CH/H-3	HH-43	HH-53
Engine/FOD	26	105	114	11	9	2	8	22	2	16	18	7
Propellers/Rotors Transmissions	N/A	N/A	52	N/A	N/A	N/A	N/A	3	—	5	10	3
Flt Controls/Trim Spoilers/Flaps Autopilot	21	107	9	2	11	—	1	3	—	1	3	1
Electrical System	1	3	4	—	8	—	—	—	—	1	2	—
Hydraulic System	28	18	6	1	—	—	1	2	—	—	—	1
Pneumatic System	3	5	9	—	—	—	—	—	—	—	—	—
Landing Gear/Tires Brakes/Wheels	43	54	14	3	4	2	7	13	—	—	2	2
Other Systems	14	43	27	3	2	1	2	1	1	1	1	—
False Fire Warnings	6	19	5	—	1	—	1	6	—	1	1	4
Dropped Equipment & Objects	15	138	23	10	—	3	—	5	2	10	1	5
Birdstrikes	1	55	6	8	—	13	3	5	—	—	2	2
Lightning Strikes Static Disch/Hail	—	9	5	—	—	—	—	—	—	1	—	—
Hypoxia/ Depressurization	1	1	3	2	1	—	—	1	—	—	—	—
Landing/Takeoff Taxi/Ground Mishaps	4	9	1	—	—	—	—	—	1	2	4	—
Aerial Delivery/ Pickup/Hoist Malfunction	0	5	6	—	—	—	—	—	2	1	4	—
Other	1	31	2	—	1	—	—	—	—	3	—	4
Totals	164	602	276	43	39	18	23	61	8	35	48	29
									Grand Total: 1346			

Chart 2

incidents in MAC this year. This number far exceeds last year's record high of 991. Most of this increase is attributable to USAF's expanded reporting requirements, instituted early in the year. Another reason for the numerical increase is that our aircraft are becoming larger and more complex, so more malfunctions are bound to occur.

We'll briefly discuss some of the highlights of the chart to explain more clearly the problems and the corrective actions we've taken.

Engines

Although engine shutdowns were relatively frequent, in most cases the engine itself was not at fault. In fact, when it comes to failures of the basic engine, our failure rate is remarkably low, especially in turbine engines. If we could only keep from loading engines with cantankerous junk like props, gearboxes, and generators, our engine shutdowns wouldn't amount to more than a couple dozen a year. However, we'd rather not have any, especially if the aircraft only has one engine to begin with — like our HH-43s and TH-1Fs. When they lose their one and only, they're going down — and autorotation is far from an exact science.

C-141 Flight Controls

Playing the numbers game a bit further, we incurred exactly the same number of C-141 flight control incidents as the previous year, but once again, the figures are misleading. We feel the increased number of incidents was partly attained by more thorough reporting by aircrews and the malfunctions aren't nearly as gut-wrenching as they have been. Most of the difficulty has been traced to contaminants (dirt) in the hydraulic fluid that provides the muscle to the Starlifter's flight control system. Stricter microfod prevention measures, including finer (five micron) filters, should prove effective in screening out the barely visible matter that can constipate the

various valves and pinhole passages controlling the flow of fluid in the system.

Fire Warnings

Next, let's talk about fire warnings — false and otherwise. Over the years, just about every type of aircraft in the MAC inventory has been plagued by fire/overheat detection systems that activated when no fire or overheat condition existed. MAC required an incident report for these malfunctions and, as time went on, we accumulated hundreds of such reports. In the latter half of 1971, the MAC Safety Division (with the concurrence of the MAC Staff) decided to eliminate the reporting requirement for these fire warning malfunctions except for cases where a fire or overheat condition actually existed and the detection system failed to function. We arrived at this decision after concluding that false fire warnings were less a critical hazard and more a downright annoyance to the crew, causing precautionary engine shutdowns and mission aborts.

Another factor supporting our decision was the record of the C-141: numerous false fire warnings but no accidents attributable to this condition in over 3 million C-141 flying hours.

Ironically, we now find the C-5 contributing a new twist to the "old bogus warning game." It seems that the warning system on our friend Fat Albert is so insensitive that nothing short of Dante's inferno will excite it. This is a distinct turnabout from systems that light up at the heat from a maiden's blush. Rest assured there is plenty of action under way to cure both maladies.

Dropped Objects

Dropped objects have been a matter of concern for several years and, in MAC, the situation is worsening. Most of our aircraft types showed a significant increase in this category, with the C-141 leading the pack. The C-141 parts most frequently shed are latrine servicing access doors, single point refueling caps, LOX servicing doors, and engine pylon blowout doors. Poor design is to blame for most of the separations, and a modification is in the mill to improve the situation.

Not all the blame can be placed on engineering however. Improper installation is still a significant factor and worn components should be replaced before they reach the separation point.

Before the '141s get an inferiority complex, let's discuss some other birds that have dropped a few. As a helicopter was flying around with its doors open, an unsecured metal box containing the G-file (about 25 lbs) slid from under a seat and fell out the door. Luckily no one was hurt, but the needlessness of this incident should be obvious.

Another example: several C-130s lost crash position indicators (CPI) in flight because water had accumulated in the cannon plugs. It was determined that the water got into the plug as the aircraft went through the wash cycle. It seems that the plugs were waterproof as long as the moisture came from the normal direction of airflow (from the front), but during washing, the cannon plugs were squirted from all directions. Now our illustrious wash crews put a protective covering over these components and that appears to have resolved the trouble. (Units possessing other aircraft might take heed; cleanliness may not always be next to godliness.)

Believe it or not, we had several incidents in which the dropped objects were wheels — yes, that's right — *wheels!* A couple of our C-5s lost wheels in flight (partly attributable to design deficiency) and there were also two incidents in which C-141s dropped wheels. In the latter instances, the cause was, purely and simply, improper installation.

Foreign Objects

Next subject on the agenda is foreign object damage — FOD. Probably your first thought about FOD is engine damage, and rightly so. Our annual dollar loss due to engine damage from swallowing up nuts, bolts, tools, chunks of pavement, etc, is enough to make Aristotle Onassis clutch his wallet. But the damage to tires, propellers, and other components is also costly. The cure to most of this problem is just plain good housekeeping. Ramps, taxiways, and runways should be constantly kept clean of objects capable of producing FOD— many an aircraft tire has been completely ruined by running over a bolt less than an inch long. Also, strict tool accountability is a must — the habit of leaving tools in engine inlets and cowlings, even momentarily, is just asking for trouble.

Fauna Strikes

The animal kingdom was very unkind to us last year— reverse ecology, you might call it. Not only did we have a plethora of birdstrikes, but we got clipped by a couple of deer and a rabbit. The "rabbit strike" was actually a combination shot: A C-141 was thundering down the runway near liftoff when a large hawk carrying a rabbit flew directly in front of the aircraft. Both critters hit directly behind the radome with a resounding thud. The C-141 came through unscathed, though many of our aircraft really got dinged hard. One musclebound honker on the east coast bunged up a C-5 engine to the tune of $65,000. We're really glad that ostriches can't fly.

Exhaust Strikes

Jet blast incidents cropped up several times during the year. A C-5 blew loose some aluminum matting (again!) and in two separate incidents, C-141 jet blast caused damage to some vehicles and overturned a couple of light aircraft. In addition, the optical landing systems at two navy bases received blast damage — one by a C-5; the other by a '141. You don't suppose they're trying to outdo each other?

Cargo Troubles

One last problem area: improperly prepared or leaking cargo that caused numerous inflight aborts. Often an airshipped vehicle has too much gasoline in its tank and a change in altitude or attitude can cause fuel to pour out into the cargo compartment. The same holds true for aircraft engines supposedly drained for airshipment.

Most everyone knows the hazards associated with fuel spills or fumes in an aircraft, but many are not aware of the dangers presented by numerous chemicals and agents that are frequently airlifted. Some burn, some are toxic when inhaled, and others are highly corrosive, both to personnel and aircraft. One of our most costly mishaps involved a C-5 where a liquid spill was not identified as acid and consequently was not adequately cleaned up. During a subsequent periodic inspection, extensive corrosion was found in several structural members beneath the flooring. Acid spills require prompt, thorough neutralizing and clean up. Aircrews should be sure to make 781 entries in the event of a spill, even if you're not sure what the stuff is.

DOWN BUT NOT OUT. Superior pilotage kept damage minor and Dash One procedures have been changed to preclude future occurrences.

C-141

Now that we've covered most of our general problem areas, let's review several of our incidents for their individual merit.

The Un-Crew. The leadoff spot belongs to a crew (non-crew?) tooling across the Pacific in a C-141 at night. The aircraft was flying at flight level 330 above the clouds and the autopilot was engaged. The aircraft commander was in the left seat and the copilot's seat was unmanned. As the '141 passed a checkpoint, the navigator issued a heading change of about ten degrees and the pilot rolled the aircraft into a 30 degree left bank using the autopilot turn controller. As the aircraft was turning, the pilot diverted his attention from the flight instruments to position report information. He turned up the overhead C-4 light and lost outside visual reference. While still in the turn, the autopilot malfunctioned, causing the aircraft to gradually assume a nose low attitude that went unnoticed by the pilot and crew. After about 30 seconds, the flight engineer (well done, sarge!) noticed a loss in altitude and alerted the pilot, who returned his attention to the aircraft instruments and found he was in a 45 degree bank with the airspeed increasing to mach .85 (limit .825) and the vertical velocity indicating big numbers — down, of course; the altitude loss was already over 5,000 feet. Immediately disengaging the autopilot, the pilot initiated a rolling 2.5-g pullout. Back at altitude, the crew determined that the bird was still intact and — ironically — the autopilot was functioning normally again. The aircraft showed no evidence of structural overstress. The aircraft was diverted to home station for further inspection. The flight data recorder readout pretty well confirmed the crew's statements. Surprisingly, the aircraft showed no evidence of structural overstress.

The Form 781 contained several previous autopilot writeups, all signed off when the malfunctions couldn't be duplicated on the ground. A more comprehensive bench check of all units of the basic autopilot system was conducted and several ailing gyros and servos were found, so inadequate maintenance contributed somewhat to this mishap. However, these inadequacies can't justify the pilot's failure to monitor aircraft attitude — especially to this extent. The navigator wasn't too swift either, because the aircraft heading changed 45 degrees and he didn't catch it. Remember, flying a transport aircraft is a team effort.

(Additional note: If the aircraft had crashed at sea, who would have ever suspected this cause factor?)

Oxygen Shutoff. Most of the aircraft in the MAC

fleet are high flying jets, so the prospect of depressurization is ever present. Normally, if the crew is knowledgeable, and the oxygen system and related equipment is in good working order, loss of pressurization is no great threat. But if the oxygen system also fails, the wicket gets stickier, especially if you're high over the middle of the ocean with not much fuel to spare. Here's a true story of a MAC crew that lost pressurization *and* the oxygen system; fortunately, it occurred during climbout and the aircraft returned to the departure base.

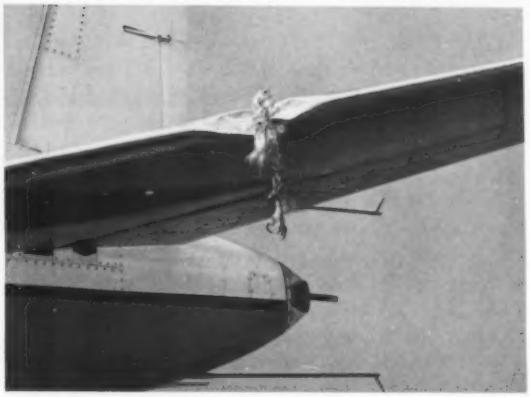
Depressurization occurred with a loud bang at about FL 200. Following emergency descent, the crew oxygen system pressure dropped to zero although 20 liters of oxygen remained. The crew couldn't discover the reason for the pressure drop, but since they were at an altitude where lack of oxygen was not a problem, they concentrated on bringing the aircraft back.

Maintenance personnel at the departure base checked the bird and discovered that the oxygen pressure shutoff valve had been safetied *closed* instead of open. They removed the safety wire, positioned the valve to open, and oxygen pressure was immediately restored. Apparently the valve had been improperly positioned and safetied on the previous day, when, during the preflight, the engineers found the shutoff valve safety wire was missing. A maintenance technician then safetied the valve to what he thought was the open position. The oxygen pressure trapped in the lines still registered within the normal pressure range, so the improper valve position went unnoticed until the depressurization.

C-5

Nose Gear Collapse. The Galaxy has a way of generating excitement and here's an incident in keeping with its character.

It occurred at an overseas base where the C-5 had been scheduled to spend several days to familiarize maintenance personnel with its maintenance and servicing. After the allotted ground time, the aircraft was prepared for a return flight to the states. Takeoff was uneventful and the C-5 climbed out for two minutes with the landing gear extended waiting for the wheels to spin down. After the prescribed waiting period had elapsed, the gear handle was moved up. The main gear retracted normally, but the nose gear remained down. All electrical circuits and other components of the nose gear checked okay. The pilot, in consultation with the panel engineer, thought the problem was electrical, similar to some previous gear malfunctions, so they decided to recycle the gear. The gear handle was placed down and the main gear extended. Then the handle was moved up and the main gear again retracted normally, but at the same time a loud bang was heard and the nose gear moved off the downlocks to an intermediate position.



GRAPHIC EVIDENCE OF A BIRD STRIKE imbedded in the horizontal stabilizer of a T-39. The C-141s and C-5s had their share of "fowling" too. One honker collided with a Galaxy engine to the tune of $65,000.

The aircraft was orbited while extensive consultation was made with several command posts and other sources. After several hours they all decided the nose gear was not going to lock down and the crew was directed to land with the partially extended gear. The aircraft landed on the prefoamed runway, and after about 4,000 feet of ground roll, the nose gear folded into the gear well. Damage was relatively minor and the aircraft was soon returned to service. The primary cause was undetermined, although several actuators and switches may have malfunctioned intermittently.

Now, in most other MAC aircraft, if you move the gear lever up and one or more gear remain down and locked, the desirable course of action is to place gear lever back down and leave it down. In other words, don't mess up a safe, down and locked condition. But the C-5 procedure, because of the pivoting of the main gear trucks during the retract cycle, prescribed recycling of the gear under certain conditions. Because of loose wording and lack of a separate procedure for the nose gear (which does not pivot during retraction) the crew went the recycle route, which caused the nose gear to move from a down and locked position. The flight handbook has been revised and now a separate procedure for the nose gear specifically cautions against recycling. A variation of Murphy's law goes something like this, "If a procedure can be misinterpreted, it will be misinterpreted." Technical writers take note.

T-39

FOY (Foreign Object Yaw). Here's a T-39 incident that should vividly remind our aircrews and maintenance types that FOD can manifest itself in many ways.

The Sabreliner was descending en route to destination. While passing 15,000 feet at 330 knots, the rudder started to drift left but was controlled with trim. Suddenly, the rudder went hard full left and the aircraft yawed approximately 60 degrees. Turning the trim selector switch off and then to alternate, the pilot tried unsuccessfully to trim out the rudder forces. He then moved the trim selector back to off, pressed the trim disconnect button, and again using alternate trim finally brought the rudder to neutral. Both pilots were applying full right rudder. They regained control passing 9,000 feet, declared an emergency, and landed safely. The culprit: a loose washer lying on the rudder trim control electrical terminal strip, causing the left rudder trim actuator to short out.

Helicopters

No MAC incident review would be complete without a couple of helicopter mishaps. Many people don't realize that MAC owns almost three hundred choppers and operates the only helicopter training center in the Air Force. Because of the unique nature of the helicopter, the hazard potential is greater than in most other MAC activities. Take FOD for example: choppers often create their own problems by whipping up loose objects which are promptly ingested by the engines.

As mentioned earlier, engine failure in a single-engine helicopter means a forced landing is inevitable and an autorotation landing is chancy at best. Take, for example, the following incident:

Five Short Ones. The Huskie made a running takeoff, then a shallow turn to position itself over a hard surfaced area for some training maneuvers. At an altitude of 50 feet and an airspeed of about 40 knots, a loud bang was heard and felt by the crew and the chopper immediately began to lose altitude — power loss was immediate and complete. The problem was quickly diagnosed as engine failure and an autorotation was initiated, followed by a sharp turn to get to the hard surface. Five short seconds after the bang, the chopper touched down fairly hard but essentially intact. Damage was limited to a broken auxiliary landing gear and one main gear driven partly into the fuselage.

In some past engine failures we've had HH-43s roll over and flail themselves to pieces, so the episode was a masterful piece of work by the pilot. Internal failure of the engine was the cause. The Huskies are now getting newer, more powerful engines, so maybe the failure rate will decrease.

Buff Hover Fix. Our next and last helicopter incident involves one of our HH-53s — a pretty sophisticated piece of equipment. The bird was in a normal cruise configuration at 9,000 feet when the master caution and the second stage tail rotor servo caution lights illuminated. Almost simultaneously, the utility hydraulic pressure went to zero. Emergency procedures for the utility hydraulic failure were accomplished, and an emergency return to home base was initiated. While en route, the landing gear was lowered using the emergency extension system. After actuation the main gear indicated down and safe, but the nose gear indicated unsafe. A wingman estimated the nose gear was about ten degrees out of the down and lock position. Procedures to cope with this situation were employed with unsuccessful results. Upon arrival at the home base, the HH-53 was hovered a few feet off the ground while a couple of intrepid maintenance personnel stood under the aircraft, manually forced the nose gear down and inserted the gear pins. The subsequent landing was uneventful.

A Plea —

This ends our parade of incidents. Hopefully you've found them interesting and informative. As you've probably noted, we're still making silly mistakes and bending airframes. In spite of this, our safety posture is improving; some of these incidents would have been disastrous if it had not been for superior aircrew performance. Aircrewmen are really our last line of defense against accidents.

You aircrew members can further aid our cause by ensuring that all mishaps are properly reported. On one hand, these reports alert us to problem areas. On the other, volume alone helps get results. Often we can't get other agencies to act unless we have sufficient documentation in the form of accident reports, hazard reports, unsatisfactory materiel reports, and the like. Your individual mishaps may seem inconclusive, but when combined with similar occurrences the trend is really apparent.

It may be significant to note that in the early '60s there were relatively few incidents each year, but our aircraft accident rate was much higher. In later years, the number of incidents reported increased greatly, but our accidents decreased steadily until now the rate consistently hovers around .60 accidents per hundred thousand flying hours. That suits us safety types fine; we'll happily investigate 10,000 incidents if it means we can reach an accident rate of zero.

1971 FLYING SAFETY AWARD WINNERS

MAC TROPHY

Air Weather Service

The MAC Trophy for Flying Safety is awarded to the MAC air force or service with the most effective flying safety program for the calendar year. *Air Weather Service* earned this coveted award by completing 1971 without a major or minor aircraft accident while flying through extremely hazardous meteorological conditions. This accomplishment is evidence of an active and aggressive flying safety program. Every man and woman in Air Weather Service contributed to this superior performance. To each of them we say congratulations for a job Well Done!

SPECIAL AWARD FOR FLIGHT SAFETY ACHIEVEMENT

The Special Award for Flight Safety Achievement is a new award given to the best wing from among those receiving MAC Flight Safety Achievement Plaques. The *89th Military Airlift Wing* won this award for 1971, and THE MAC FLYER proudly congratulates the men and women of the 89th for a job Well Done!

FLIGHT SAFETY ACHIEVEMENT AWARD

MAC Flight Safety Achievement Plaques are awarded to wings with the most effective flying safety programs for the calendar year. THE MAC FLYER proudly congratulates:

63 MAWg	89 MAWg
438 MAWg	40 ARRWg
437 MAWg	9 WRWg

SUPPORT SAFETY ACHIEVEMENT AWARD

MAC Support Safety Achievement Plaques are awarded to military airlift support squadrons which provide excellent services and have sound and successful accident prevention programs. Congratulations go to:

603 MASSq
611 MASSq

After terminating his flight with a splash down off Guam, the Ace of All Aerospace makes the most of the situation as he steams into port aboard a Russian Trawler.

C.R. TERROR

AS THE SLEEK STARLIFTER rolled to a stop in front of Wake Operations, C. R. and crew were waiting patiently in the crew bus to get a debriefing from the inbound crew. Watching the contract maintenance crew swarm over the aircraft, C. R. was already daydreaming ahead to post mission activities.

Ahh, a daylight leg to Clark, and landing in time to sip a cool San Miguel at pool side. With the phase down in Vietnam, the female-to-male ratio has improved considerably.

Abruptly, a slap on the shoulder brought him back to reality. "Hey, you old rascal, how the heck are you?"

The voice and hand slap belonged to none other than Will Slicker, a flying school classmate. "The bird's in pretty good shape," Will continued. "We have one CSD disconnected but everything else is fine. Have fun at Clark. Maybe we'll catch up to you there." C. R. nodded in agreement and exited the bus. The rest of his crew were already busy loading bags and trying to get as much checked as possible before the ground crew started refueling. The Ace Aviator threw his bags aboard and eyeballed the cargo; nine pallets of toilet paper, mission essential, he thought. He shook his head and walked back to the cockpit. A quick check of the 781, and then he placed his oxygen mask and checklist on the left seat and went outside. The maintenance men were hooking up the refueling hose and the rest of his crew were strolling toward the terminal. That is, all except Sgt Torque, who turned from his conversation with the crew chief.

"Major Terror, did you know that number 4 CSD is disconnected?"

"Yeah, I know, but we got three more, so no sweat."

"Two and a half maybe. I was talking to the engineer on the other crew and he said they had another one that had been fluctuating on the leg in here. They didn't write it up because it finally settled down."

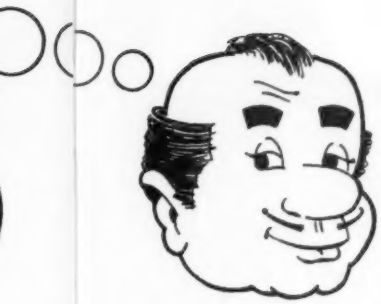
"Let it not worry you," the Silver Tongued Fox assured Sgt Torque. "They told us at Tinker that one of these generators could supply enough power to light up Midwest City." Torque tried to protest but the Prelate of Pilotage hushed him with a wave of his hand and waddled toward the terminal for one last hot dog.

* * *

Refueled, and engines started, they taxied to the runway. Sam copied and read back the clearance and departure instructions.

Then the Gross Gripper of Go Levers taxied onto the runway, jammed the throttles forward, and soon the bird was airborne. Climb to altitude went smoothly, but just after level-off at flight level 350, Sgt Torque called, "Pilot, engineer!"

"Roger dodger, Max baby, what-



cha want?" C. R. answered, his thoughts on another night at the White Elephant with Molly, a pretty little nurse he met last trip.

"Sir, the temperature on number 3 CSD is just about off-limit hot and I'll probably have to disconnect it."

"Well, keep an eagle eye on it and keep me advised. We can make it on two."

"Roger boss, but the real problem is we might be down to one."

"How's that?" shot the Rotund One, as he turned toward the engineer's panel to see what Torque was talking about.

"You remember what I told you about the CSD they didn't write up? Well, it's okay. But number 2 is fluctuating now." Sgt Torque had that look of concern on his face.

The Bald Baron of Bordellos took a deep breath and asked, "Okay, so we lose number 3 because of overheating and number 2 from fluctuations; then what?"

"Well . . . nothing sir. One generator will run everything. The thing to worry about is if we lose the last one."

"Man, you are a worrier. Mr. Lockheed *guar-on-teeed* that you'd never lose all four at one time. Not a chance in a million for it to happen to us." The Proud Pontificator turned away, leaned back in his seat, and started to formulate his plans for the evening. Long Suffering Sam was busy reporting 100 miles out on HF and Blinky was already eating his flight lunch. As Sam finished the position report, C. R. spoke.

"Sammy m'boy, you have it. Wake me if anything exciting happens. That poker game kept me up a little late last night." With this, he propped his head on the seat cushion and closed his eyes.

The next few hours slid by without a hitch. Then Sgt Torque broke the silence. "Copilot, engineer, I just disconnected number 3 CSD for being off-limit hot."

C. R., disturbed by the interphone conversation, opened his eyes. "Torque," he complained, "will you quit beating your gums about CSDs! We'll just slip into Clark on two and let maintenance worry about it." Suddenly the remaining two generator out lights illuminated and the Starlifter slowed as the engines flamed out. C. R. sat up like a bolt!

"Whatthehellishappening?" gasped the Aerial Ace. It was really eerie — all the annunciator lights were flashing like a Christmas tree and the emergency generator was clicking off and on, as Max Torque frantically tried to get a generator back on the line before the engines spooled down below 54 percent. Everytime he reset number 1, the only good one, it too would kick back off. Torque couldn't believe it; how could number one be going bad on him now? The one time in a million had just happened. All four were bad!

Unknown to the frantic engineer, number 1 generator had an intermittent short causing a surge on number 2 generator. Consequently, every time Max reset number 1 the surge would kick off number 2 also.

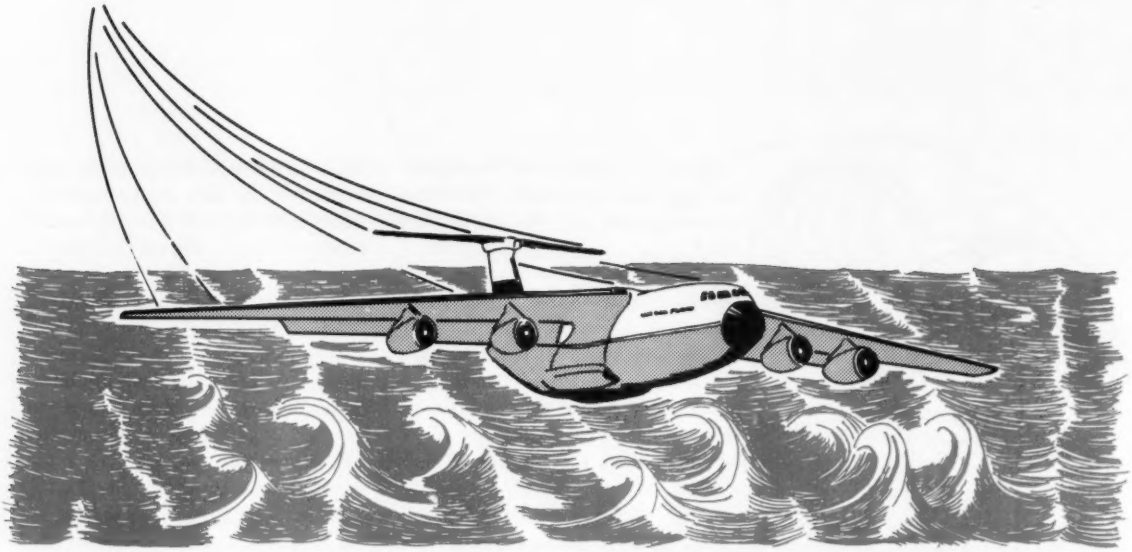
"What can I do?" he wailed as his eyes raced around the panel. Unfortunately, he never thought of going into isolated generator operation until it was too late.

"Man, I need some motors!" C. R. cried. "How come the engines flamed out? How come I can't get an airstart?"

Torque, too busy to really talk, blurted back, "Because the ambient air pressure is too low to allow suction feed by the engine driven fuel pumps and we've lost power to the main tank boost pumps. Can't you dive this thing some more so we can get the rpm back up to 54 percent? I need to get a generator back on the line."

"We're going straight down now," shot C. R., his pudgy knuckles white as he gripped the yoke. He glanced at the airspeed — cross-hatched — and the rpm was still below 54 percent!

Then his grip loosened and a relaxed note entered his voice. "Hey, troops, no sweat. When we get down lower where the air pressure is higher, we'll be able to get an airstart. So sit back and relax whilst I fly our glider."



"No sir," Torque quickly responded, "we can't get an airstart without ignition. And the only way to get ignition is to get the rpm to 54 percent and get a generator back on the line. And there is no way we'll get the rpm up from just windmilling!"

"Crimenently, that means we *are* going to ditch!" he wailed. It was obvious to the crew that they were going to go swimming — or worse. With the Prince of Pilotage still trying to get an airstart, the rest of the crew prepared for ditching.

Sam was able to make contact with another C-141 inbound to Wake, and Blinkey gave them a position report. C. R. watched the ocean as they rushed toward it trying to remember what waves and swells were, whether to land in them, on them, or between them, parallel or perpendicular.

"Oh, this has to be a bad dream. I've got to wake up!" he shuddered.

As the initial shock passed, the uncalm, un-cool, and un-collected Lothario of the Airlift Game put on his pigskin flying gloves and bellowed, "Prepare for ditching! If you see an oasis anywhere, yell! I'll try to put us down on the beach." Try as he might to stay relaxed, the sweat poured from his time-worn brow. This is it, he thought. I've really ripped it.

"Hey, chief," Sam cut into his thoughts, "there's a boat at about two-thirty, three miles." C. R.'s head swivelled around and, sure enough, there was a fishing trawler.

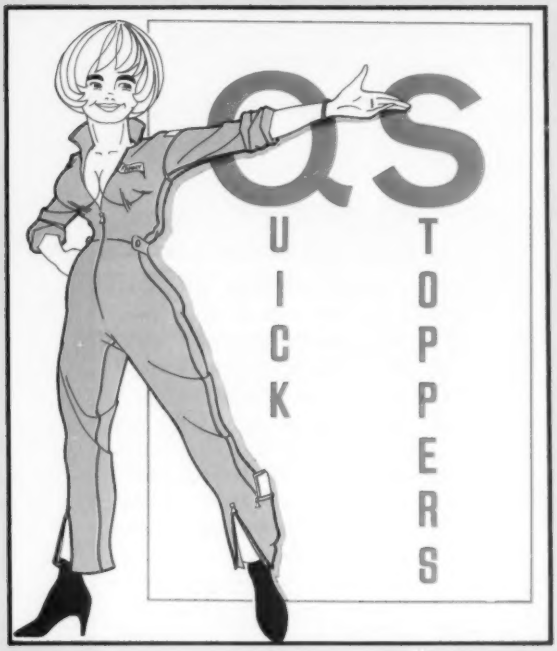
"Man, what luck; we'll be eating mackeral tonight," he boasted. Blinky and Sam looked at each other and sighed a silent, "We're saved!" And then a look of despair covered the entire crew's face as they saw a blood-red banner with the gold hammer, sickle, and star, flying from the trawler's flagstaff.

The Master Manipulator was not about to go looking for a friendlier boat and gently banked his Lockheed glider toward the small Russian trawler, barking out his final ditching instructions. "If these fine fellows can't speaka da English too well, just let me do the talking and do everything I do. We don't want to rattle their cages."

Moments later C. R. yelled, "Hang on!" and then they hit . . . What seemed like years was actually seconds, and then the entire crew found themselves bobbing in the briny deep, like corks; none of them sure how they got there. As C. R. surfaced, he saw the T-tail sinking out of sight and Blinky making like a whale, blowing his whistle with the water spouting from the small hole.

C. R. was laughing within seconds after he was pulled aboard the trawler. To his surprise his host spoke excellent English and introduced himself as Igor.

By the time Sam, Blinky, Max, Clyde, and Ty were aboard, the Chief Charmer had the entire Russian crew laughing and breaking out the vodka. C. R. then turned to his crew, raised his glass and said, "Cheers, troops. Our friend Igor will take us to Guam." Spilling a few drops of Igor's 190-proof, 20-year-old vodka he added with a slur, "He said he was headed that way anyways."



Joys of Being an Editor

Getting out this magazine is no picnic.
If we print jokes, people will say we are silly;
  If we don't, they say we are too serious.
If we clip things from other magazines,
  We are too lazy to write ourselves;
  If we don't, we are stuck on our own stuff!
If we stick close to the job all day,
  We ought to be out hunting up articles.
If we do go out and try to hustle,
  We ought to be on the job in the office.
If we don't print contributions,
  We don't appreciate true genius;
  If we do, the magazine is filled with junk.
If we make a change in a fellow's article,
  We are too critical,
  And if we don't, we are asleep!
Now, like as not, someone will say we swiped this
  From some other magazine.
WE DID!

Still Smoking?

Is there a definite relation between smoking and higher death rates? Or is there a good chance that some other factor is the killer and smoking is only an innocent bystander? While the medical powers believe rather firmly in the first condition, it takes only a few minutes on a flight deck — or in a safety office — to show that many of us are still clinging to the secret factor theory.

As part of a cancer prevention study, almost half a million volunteers were screened in terms of 19 factors — including environmental, hereditary, physical, social, and medical characteristics. At the end of the screenings, the computer coughed up almost 37,000 matched pairs made up of one smoker and one nonsmoker who were otherwise identical in the 19 factors. After a little less than three years, 2,047 had bit the dust (3.7% of the total pairees) with smokers expiring more than twice as often as nonsmokers. Ratios of causes of death: lung cancer — smokers lost 9:1; coronary artery disease — 2:1 against the smokers; emphysema — 7:1 losses for the nicotine set.

Those still searching for the secret factor may also try to fill inside straights or play chicken with Amtrak.

Thought for the Day

Counterfeit Clearances

Last fall, a civilian airliner, over the central United States, received two clearances from an unidentified source. The flight had departed O'Hare and was about 60 miles out of Cincinnati at 11,000 feet when a weak but audible transmission cleared them to descend to 1,000 feet. The captain asked Indianapolis Center to repeat the clearance, and the controller replied that he had not issued any clearance. Moments later a second transmission cleared them to descend immediately to 1,000 feet. Again, the captain requested confirmation and again was informed that no clearance had been issued. After landing at Cincinnati, the pilot gave the controller a detailed debriefing.

The mysterious clearances were not recorded on the center's tapes, apparently because the transmission came from a source beyond the center's line of reception. Speculation is the transmissions came from a prankster who was familiar with air traffic control procedures.

This incident clearly points out the value of reading back all ATC clearances. It's our only protection against possible voice jamming — wherever we fly.

(American Airlines FLIGHT DECK)

Crunched Cowling

During postflight inspection of a C-141 at an off-shore base, the ground crew was startled to see the cowling of number two engine unlatched and wedged tightly around the engine. The cowling was secure on top but the leading edges of the left and right cowling door panels were warped backwards 20 degrees, and both doors had many rivets popped. Because of the warping, the leading edges were in a negative pressure area which prevented complete cowling separation from the aircraft. When the pieces were taken off and matched up, all the latches worked like they were designed to.

One leg and four and a half flying hours up the road, the cowling had been opened to check the engine for an oil leak. Although the discrepancy had been signed off, the cowling had not been relatched — nor had the cowling checker done his job. Sure would have put a kink in international relations if we'd bombed a school with a couple hundred pounds of cowling.

Worn Out Air

Repeated use of the same landing and takeoff patterns by thousands of planes at busy airports seems to be affecting the air density in these critical areas.

This is the unique discovery of Erich Mueller, AF, DK, professor of aerodynamics at Ludicroesse University.

In studies of airport patterns at several busy airports, Prof. Mueller found that weather balloons released directly below the landing-approach areas indicate that the air became thinner, or more nearly worn out, in these areas. The same phenomenon seemed to hold true in takeoff areas.

The discovery seems to indicate, the professor said, that eventually airport runways will have to be relocated.

After further study, Prof. Mueller intends to direct his research to harbor areas, to determine whether the same thing may be happening to the water in heavily traveled sea-lanes.

Asked what the initials after his name stood for, Prof. Mueller said, "April Fool, DumbKopf!"

Courtesy — Delta Airlines, UP FRONT

Calling Confusion

Cargo was being offloaded from a C-5 when the crew suddenly got an indication of fire in the left APU compartment. They made a call on UHF, reporting the fire and requesting a fire truck. It took almost ten minutes for the fire equipment to show up, and the crew was more than miffed at what they considered an excessive delay.

A little research disclosed that most of the delay was generated by the crew themselves. When they discovered the problem they promptly reported it—which was fine — but they called the airlift command post, not the control tower. ACPs have no access to the crash net, and they cannot alert emergency equipment as quickly as the tower people can.

It seems that calling for help may not be enough in some cases. You've got to be sure the person you call is the one who can help you the most.

FSK Fiasco

A student HH-43 pilot had completed six practice fire exercises and, with the fire suppression kit dangling beneath his trusty Huskie, was approaching for another. Suddenly, while the bird was about 75 feet in the air, the cargo hook light came on indicating that the FSK was no longer a participant in the proposed exercise. Sure enough — the kit had fallen free and destroyed itself on the cold hard ground below.

A careful look at the aircraft and the release system could uncover no malfunctioning hardware, so the probable cause was chalked up as (have you guessed yet?) operator factor. The investigators felt the student pilot had probably hit the cargo release button while using the trim release during the final portion of the approach to the fire.

Corrective action included the usual "Briefed all pilots . . ." and "Increased emphasis will be placed . . ."

A typical incident? That's right, and that's the problem. It's too typical. We've been accidentally dropping FSKs from the HH-43 long enough. Maybe it's about time somebody figured out a real fix. Anyone got any ideas?

Don't take chances!

Tell it to The MAC Flyer

and let us tell the world

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